



Implementation of Ethno-Edugames Application to Improve Student Learning Outcomes

Novita Permata Sari^{1*}, Kartika Ratna Pertiwi², Anggi Tias Pratama²

¹Master of Biology Education, Universitas Negeri Yogyakarta, Yogyakarta, Indonesia.

²Department of Biology Education, Faculty of Teacher Training and Education, Universitas Negeri Yogyakarta, Yogyakarta, Indonesia.

Received: September 08, 2024

Revised: December 19, 2024

Accepted: February 25, 2025

Published: February 28, 2025

Corresponding Author:

Novita Permata Sari

novitapermata.2022@student.uny.ac.id

DOI: [10.29303/jppipa.v11i2.10100](https://doi.org/10.29303/jppipa.v11i2.10100)

© 2025 The Authors. This open access article is distributed under a (CC-BY License)



Abstract: The writing of this article aims to present the results of the analysis in the form of a literature review on the results of research on the implementation of the ethno edu games application to improve student learning outcomes. The ethno-edugames application is an educational game with the concept of local wisdom in the form of traditional games packaged into an application on a smartphone as a learning medium. The articles used consist of 4 research articles from national and international journals. The research procedure used in writing this article with 5 steps of literature review, determining the research theme, namely the implementation of the ethno edu games application to improve student learning outcomes, searching for and collecting various articles on the sinta website, google scholar, and other websites, classifying various types of articles that are relevant to the research theme, synthesizing relevant articles by marking important points in each article; and writing articles from the results of the synthesis. The conclusion of this article is that the use of ethno-edugames media in learning has succeeded in improving student learning outcomes. Ethno-Edugames that have succeeded in improving learning outcomes are, hopscotch, bebetengan, and Snakes and ladders.

Keywords: Application; Ethno-edugames; Learning outcomes

Introduction

As we know, today's school students are very different from the past, this is due to the increasingly advanced development of the era, so that the way to educate them must also adjust to current conditions (Akour & Alenezi, 2022; Zain, 2021; Leonardi & Treem, 2020). Educational institutions can be schools that are designed to carry out an educational process in the form of teaching or training for students with the aim of developing the potential within students and changing students' attitudes for the better. Learning is an interaction between teachers and students through the help of tools and teaching materials in a learning environment with the aim of providing assistance to students to learn new things, increase insight, improve skills and shape students in growing self-confidence

(Djamaluddin, 2019; Puntambekar, 2022). The learning process carried out by an educator in a school is required to be able to increase knowledge, critical thinking and creativity in students and student behavior during the learning process or outside the learning process needs to be considered, so the accuracy of the learning process requires more attention and besides that the learning process carried out should also adjust to the conditions of the students at that time (Hardhienata et al., 2021; Ghory & Ghafory, 2021).

Students or learners are greatly influenced by the development of technology that continues to occur with one of the evidences that the use of technology in the form of smartphones or gadgets that are already familiar in the school environment for students (Bacolod, 2022; Churchill et al., 2018). We as educators should be able to make breakthroughs or new innovations in teaching and

How to Cite:

Sari, N. P., Ratna, K. P., & Pratama, A. T. (2025). Implementation of Ethno-Edugames Application to Improve Student Learning Outcomes. *Jurnal Penelitian Pendidikan IPA*, 11(2), 264–273. <https://doi.org/10.29303/jppipa.v11i2.10100>

learning activities through the use of technology, one of which is by utilizing smartphones which are generally familiar to students, so that there is a value of usefulness when students use smartphones, in addition to getting used to using technology for students in this digital era is also very important so that students are literate about technology that will continue to develop, this is one of the efforts to produce a generation of successors to the nation for a better future for the country. Smartphones can load various applications that are intended for various interests, one of which is for learning (Agung et al., 2022).

Significantly, technological developments have a major impact on the education process (Baedhowi et al., 2018; Alam, 2021). Learning that is generally carried out face-to-face by utilizing classroom facilities such as whiteboards, books and others can now be replaced with technology that can be modified into a more effective learning method and is more helpful in meeting students' learning needs, one of which is information related to learning that students can get without being limited by space and time (Heilporn et al., 2021; Nugroho, 2021; Marey et al., 2022). The use of technology as a learning medium in an educational institution is very appropriate, because in the learning process that greatly influences students' learning outcomes, one of which is the learning media used, with the renewal of learning methods, it is possible to attract students' attention to be more diligent in studying and allow students to actively develop skills that they have previously had.

The use of technology-based learning media certainly needs to pay attention to several things that are currently popular with students, one of which is games which are one of the applications on smartphones that are always played by students, so that it can be ensured that the learning media can attract students' interest (Al-Taweel et al., 2021). Student learning outcomes are expected to increase after the implementation of the learning process using technology through learning application media (Thahir, 2021; Marini et al., 2022).

Along with the advancement of technology in the field of education today, games can be used as a learning medium through the use of edugames applications. Edugames is a game application specifically designed for education which is used in educational or learning activities with various features that support the learning process (Rokhim et al., 2022; Dahnil, 2024). According to Greipl et al. (2020) if you can apply the edugames application with a good method, it can create an effective learning atmosphere and can provide positive results in the cognitive, emotional and social learning environment aspects.

Games or games used as learning media generally use modern games, this is because they follow the development of the times (Arifianto & Izzudin, 2021). Currently, the existence of traditional games has disappeared and been replaced by technology-based digital games (Anggita et al., 2018; Astari & Sudarmilah, 2019; Nurrohman, 2021). Traditional games are local wisdom that is formed from the daily activities of local residents and usually develops from generation to generation in an area and implicitly contains the identity of the values of the lives of the people in that area. Generally, these traditional games are played by groups of children (Fajarwati & Nugrahanta, 2021). Many people realize that traditional Indonesian games such as hide and seek, gobak sodor, baparak meja, bebentengan and others teach many positive things such as teamwork, being honest, training emotions, and hard work (Ramansyah, 2015).

Each region in Indonesia has different cultures and traditions. This important point is not only about the diversity that Indonesia can be proud of, but can also support learning activities in each region. The diversity of local characteristics in each region can be considered a meaningful context in the learning process. Meaningful learning can be done by adapting learning to local culture and traditions (Zidny et al., 2020). Local wisdom possessed by the community must be studied scientifically so that the values contained in local wisdom can be reconstructed into scientific science (Festiyed et al., 2022).

Traditional games have positive values contained in them, these traditional games do not rule out the possibility of being collaborated with technology to become a technology-based educational game (Toharudin et al., 2021). The attachment of the younger generation to technology is a great opportunity to reintroduce traditional games that are packaged into digital-based games (Julianus et al., 2020). Traditional games have great potential to be used as a learning medium if packaged into a game application that can be played on gadgets, so that indirectly traditional games will continue to be preserved by collaborating with current technological developments through ethno-edugames application learning media, in addition, the advantages of using this learning media are that students do not get bored easily when studying and are easier to understand the material and motivate students to be more active in studying, because this learning media uses the concept of games (Rahayu et al., 2024).

The ethno-edugames application is an educational game with a local wisdom concept in the form of traditional games packaged into an application on a smartphone as a learning medium. According to Munawaroh et al. (2023), learning using the game

method is believed to be able to build a fun learning atmosphere. Learning using the ethno edugame concept is likely to influence students to be more active in carrying out learning activities, and makes it easier for students to understand, remember the learning materials obtained from the teacher and besides making it easier, it can also help students improve their learning (Dahnial, 2024). Learning using media in the form of games can increase brain absorption and improve memory, because the activities carried out are activities that make them memorable so that they will be stored longer in the brain's memory (Kartika et al., 2019). Learning using the ethno-edugames concept can also attract students' attention, such as the display on the application is equipped with animation of the material being studied, so that it will create an impressive learning experience and allow it to be remembered for a longer period of time.

Method

This study uses a literature review research design. The data in this study were obtained by collecting articles from national and international journals published in 2022 and 2023. The research procedure used in writing this article with 5 steps of literature review, determining the research theme, namely the implementation of the ethno edu games application to improve student learning outcomes, searching for and collecting various articles on the sinta website, google scholar, and other websites, classifying various types of articles that are relevant to the research theme, synthesizing relevant articles by marking important points in each article; and writing articles from the results of the synthesis. The final result of this literature review will produce an overview of the Implementation of Ethno-Edugames Application to improve student learning outcomes.

Result and Discussion

Based on the results of a literature review from several previous studies, it shows that the implementation of ethno-edugames applications can improve student learning outcomes. This can be found in the research of Fitri et al. (2023), which states that each group in the ethno edu games game implemented in the experimental class experienced a significant increase in learning outcomes than the class that did not implement ethno edu games. The learning outcomes obtained by students must of course be in accordance with the learning objectives set by the educational institution. Baedhowi et al. (2018) stated that learning outcomes can be realized in the form of achievements achieved by

students and in the form of learning outcome scores during class given by teachers in each subject area.

The realization of the learning process achievements that have been determined by an educator at the beginning of learning reflects the success of the learning process carried out (Suarmawan et al., 2019). There are several aspects that can influence learning outcomes in students, one of which is external factors from the school environment, for example from the learning methods or models used by an educator in conveying knowledge to students in class. Based on the results of the study, the use of ethno-edugames applications greatly affects student learning outcomes, this is proven through the research data obtained. In this study, technological advances were utilized through learning applications by adopting the concept of traditional fortification games from Indonesia. The results of this study show an increase in student learning outcomes. Therefore, it can be concluded that the use of the ethno-edugames application can improve the learning outcomes of grade 8 students.

Research by Primrose et al. (2023) also showed an increase in student misconceptions. This media is used with the Engklek ethno-game strategy to support the student learning process in the classroom, both in groups and individually. The purpose of this study was to determine the level of effectiveness of the use of BRUSLE Android Apps media on students' mathematical abilities. The study was conducted on 29 junior high school students in grade IX on the Curved Side Space Building material. The study was conducted using a Mix Method approach with a Quantitative-Qualitative scheme. Data collection was carried out using questionnaires and direct observation during the implementation of learning. Learning with BRUSLE Android Apps is carried out by integrating ethno-games, namely Engklek. The purpose of using the Engklek ethno-game strategy is to provide a fun learning process for students. This is done with the hope that students will be able to follow the learning well and have an impact on improving students' mathematical abilities. The results of the study can be concluded that the BRUSLE Android Apps media is very effective in supporting the learning process to improve students' mathematical abilities.

Research from Suriyana et al. (2022) in the study can prove that digital educational games of snakes and ladders can improve student learning outcomes. This research was conducted at State Elementary School 51 Sungai Raya, Kubu Raya Regency. The study produced a product in the form of educational game media snakes and ladders. In everyday life, most people do not realize that they have applied mathematics. Most people think that mathematics can only be learned in school. In fact,

mathematics is often used in various aspects of life, for example in the snakes and ladders game. In the snakes and ladders game, players are unconsciously learning the concept of number operations. Because it is packaged in the form of a game, the concept of number operations that were previously difficult can be fun. Although often encountered in everyday life, mathematics is still considered a difficult and unpleasant subject. The method used in this study is the development method with 4-D (Four D Model). Based on the results of the validity test conducted by 2 experts, it shows a valid level of validity with an average of 3.8 with details of material experts with a score of 3.9 while media experts have an average score of 3.7 with valid criteria. Meanwhile, the effectiveness of the results of student responses is 3.52, stating that students agree with mathematics learning, especially integer operations, while the overall evaluation of the percentage of students who completed the results was 86% in Elementary Schools, which is practical to use.

Research by Rizki et al. (2022), the study successfully proved that Engklek educational games can improve students' physics learning outcomes. Engklek is a traditional game that has many physics concepts to explore, and has the potential to be applied in Ethno-STEM-based physics learning. So far, no research has been conducted to explore the physical concept of this game. Therefore, this study aims to explore the concept of physics in the traditional Engklek game and its potential application in Ethno-STEM-based physics learning. This study uses a qualitative research method with an exploratory design. Data collection uses three methods: observation, interviews, and literature studies. Data are analyzed descriptively through three stages, namely data reduction, presentation, and verification or inference. The results show that the main concepts of physics contained in this game are parabolic motion; work and energy; momentum and thrust; and rigid body balance. This game can also be applied to physics learning because it is relevant to the 2013 curriculum and the Ethno-STEM Review. Therefore, the Engklek game can be more meaningful, a fun, interactive, and contextual physics learning media. This study implies that the results of the exploration and analysis of the potential application of ethno-STEM-based science learning can be tested for future research or applied directly to physics learning. This learning is expected to improve student learning outcomes while preserving the local wisdom of the Engklek game.

Conclusion

The use of ethno-edugames media in learning has succeeded in improving student learning outcomes.

Traditional games have great potential to be used as a ethno-edugames, so that indirectly traditional games will continue to be preserved by collaborating with current technological developments through ethno-edugames application learning media, in addition, the advantages of using this ethno-edugames are that students do not get bored easily when learning and are easier to understand the material and motivate students to be more active in learning, because this learning media uses the concept of games. Ethno-edugames that have succeeded in improving learning outcomes are, hopscotch, bebetengan and snakes and ladders.

Acknowledgments

All author would like to thank to all parties who have involved in this research.

Authors Contributions

Conceptualization, N. P. S., K. R. P., A. T. P.; methodology, N. P. S.; validation, K. R. P. and A. T. P.; formal analysis, K. R. P.; investigation, N. P. S. and K. R. P.; resources, N. P. S., K. R. P., A. T. P.; data curation, N. P. S.; writing—original draft preparation, K. R. P. and A. T. P.; writing—review and editing, K. R. P. and A. T. P. All authors have read and agreed to the published version of the manuscript.

Funding

This research did not receive external funding.

Conflicts of Interest

The author declares there is no conflict of interest in writing this article.

References

- Agung, P., Kuncoro, D., & Fauzi, A. (2022). Pelatihan Aplikasi Komputer Dasar untuk Meningkatkan Kualitas SDM pada Dinas Komunikasi Informatika Persandian dan Statistik Kabupaten Teluk Bintuni. *Jurnal Ekonomi Manajemen Sistem Informasi*, 3(5), 553–563. <https://doi.org/10.31933/jemsi.v3i5.991>
- Akour, M., & Alenezi, M. (2022). Higher education future in the era of digital transformation. *Education Sciences*, 12(11), 784. <https://doi.org/10.3390/educsci12110784>
- Alam, A. (2021). Possibilities and apprehensions in the landscape of artificial intelligence in education. In *2021 International Conference on Computational Intelligence and Computing Applications (ICCICA)* (pp. 1–8). IEEE. <https://doi.org/10.1109/ICCICA52458.2021.9697272>
- Al-Taweel, F. B., Abdulkareem, A. A., Gul, S. S., & Alshami, M. L. (2021). Evaluation of technology-based learning by dental students during the pandemic outbreak of coronavirus disease

2019. *European Journal of Dental Education*, 25(1), 183-190. <https://doi.org/10.1111/eje.12589>
- Anggita, G. M., Mukarromah, S. B., & Ali, M. A. (2018). Eksistensi Permainan Tradisional sebagai Warisan. *Journal of Sport Science and Education (JOSSAE)*, 3(2), 55-59. <https://doi.org/10.26740/jossae.v3n2.p55-59>
- Arifianto, M., & Izzudin, I. (2021). Students' acceptance of discord as an alternative online learning media. *International Journal of Emerging Technologies in Learning (ijET)*, 16(20), 179-195. <https://doi.org/10.3991/ijet.v16i20.22917>
- Astari, F. W., & Sudarmilah, E. (2019). Belajar Fotosintesis dengan Edugame Berbasis Android. *Emitor: Jurnal Teknik Elektro*, 19(2), 74-80. Retrieved from <https://journals.ums.ac.id/index.php/emitor/article/view/7984>
- Bacolod, D. B. (2022). Mobile learning as a solution for restricted learning during the COVID-19 pandemic. *Journal of Digital Educational Technology*, 2(1), ep2203. <https://doi.org/10.21601/jdet/11584>
- Baedhowi, B., Triyanto, T., Totalia, S. A., & Masykuri, M. (2018). *Peningkatan proses pembelajaran dan penilaian pembelajaran abad 21 dalam meningkatkan kualitas pembelajaran SMK*. Jakarta: Direktorat Jenderal Pendidikan Dasar dan Menengah.
- Churchill, D., Pegrum, M., & Churchill, N. (2018). The implementation of mobile learning in Asia: Key trends in practices and research. In *Second handbook of information technology in primary and secondary education* (pp. 1-41). Springer. https://doi.org/10.1007/978-3-319-53803-7_54-1
- Dahnial, I. (2024). Development of Edugames on Pancasila Material to Improve Learning Outcomes of Grade IV Students in Elementary Schools. *Pedagogik Journal of Islamic Elementary School*, 83-93. <https://doi.org/10.24256/pijies.v7i2.5947>
- Djamaluddin, A. (2019). *Belajar dan Pembelajaran: 4 Pilar Peningkatan Kompetensi Pedagogis*. CV Kaffah Learning Center.
- Fajarwati, Y. E., & Nugrahanta, G. A. (2021). Buku Pedoman Permainan Tradisional untuk Menumbuhkan Karakter Empati Anak Usia 9-12 Tahun. *Jurnal Ilmiah Pendidikan Profesi Guru*, 4(3), 437-446. <https://doi.org/10.23887/jippg.v4i3.41335>
- Festiyed, F., Diliarosta, S., Elvianasti, M., & Anggana, P. (2022). Pemahaman Guru Biologi SMA di Sekolah Penggerak DKI Jakarta Terhadap Pendekatan Etnosains pada Kurikulum Merdeka. *Jurnal Pendidikan dan Kebudayaan*, 7(2), 152-163. <https://doi.org/10.24832/jpnk.v7i2.2993>
- Fitri, M., Kurniawan, I. S., & Aryanti, F. (2023). Aplikasi Ethno-Edugames (Bebentengan) sebagai Media Pembelajaran untuk Meningkatkan Hasil Belajar Siswa SMP. *EPISTEMA*, 4(2), 110-122. <https://doi.org/10.21831/ep.v4i2.63733>
- Ghory, S., & Ghafory, H. (2021). The impact of modern technology in the teaching and learning process. *International Journal of Innovative Research and Scientific Studies*, 4(3), 168-173. <https://doi.org/10.53894/ijirss.v4i3.73>
- Greipl, S., Moeller, K., & Ninaus, M. (2020). Potentials and Limits of Game-Based Learning. *International Journal of Technology Enhanced Learning*, 12(4), 363-389. <https://doi.org/10.1504/IJTEL.2020.110047>
- Hardhienata, S., Suchyadi, Y., & Wulandari, D. (2021). Strengthening technological literacy in junior high school teachers in the industrial revolution era 4.0. *JHSS (Journal of Humanities and Social Studies)*, 5(3), 330-335. <https://doi.org/10.33751/jhss.v5i3.4220>
- Heilporn, G., Lakhali, S., & Bélisle, M. (2021). An examination of teachers' strategies to foster student engagement in blended learning in higher education. *International Journal of Educational Technology in Higher Education*, 18(1), 25. <https://doi.org/10.1186/s41239-021-00260-3>
- Julianus, E., Hidayat, E. W., & Sulastri, H. (2020). Android-Based Traditional Games. *Jurnal Informatika dan Sains (JISA)*, 3(1), 21-26. <https://doi.org/10.31326/jisa.v3i1.632>
- Kartika, Y., Wahyuni, R., Sinaga, B., & Rajagukguk, J. (2019). Improving Math Creative Thinking Ability by using Math Adventure Educational Game as an Interactive Media. *Journal of Physics: Conference Series*, 1179(1), 012078. <https://doi.org/10.1088/1742-6596/1179/1/012078>
- Leonardi, P. M., & Treem, J. W. (2020). Behavioral visibility: A new paradigm for organization studies in the age of digitization, digitalization, and datafication. *Organization Studies*, 41(12), 1601-1625. <https://doi.org/10.1177/0170840620970728>
- Marey, A., Goubran, S., & Tarabieh, K. (2022). Refurbishing classrooms for hybrid learning: Balancing between infrastructure and technology improvements. *Buildings*, 12(6), 738. <https://doi.org/10.3390/buildings12060738>
- Marini, A., Nafisah, S., Sekaringtyas, T., Safitri, D., Lestari, I., Suntari, Y., ... & Iskandar, R. (2022). Mobile augmented reality learning media with Metaverse to improve student learning outcomes in science class. *International Journal of Interactive*

- Mobile Technologies*, 16(7).
<https://doi.org/10.3991/ijim.v16i07.25727>
- Munawaroh, D. A., & Rahmadonna, S. (2023). Pelaksanaan Pembelajaran Kooperatif dengan Metode Ular Tangga Berkelompok pada Siswa Sekolah Menengah Pertama. *Epistema*, 4(1), 45-57.
<https://doi.org/10.21831/ep.v4i1.61344>
- Nugroho, R. A. (2021). Pengaruh Penggunaan Brainly Terhadap Hasil Belajar Siswa. *Epistema*, 2(2), 76-82.
<https://doi.org/10.21831/ep.v2i2.41370>
- Nurrohman, A. (2021). Analisis Edugame Berbasis Android sebagai Media Pembelajaran di Sekolah Dasar. *Prosiding Seminar Nasional Sains*, 247-254. Retrieved from
<https://proceeding.unindra.ac.id/index.php/sinasis/article/view/5349/0>
- Primrose, A. T., Falah, M. F. N., Rifqi, M. I., Mauliya, D. F., & Mukti, T. S. (2023). Engklek Etno-Game dengan Brusle Android Apps sebagai Media Pembelajaran Matematika untuk Mereduksi Miskonsepsi Siswa. *Jurnal Pendidikan Matematika*, 6(1), 1-11.
<http://dx.doi.org/10.30656/gauss.v6i1.6489>
- Puntambekar, S. (2022). Distributed scaffolding: Scaffolding students in classroom environments. *Educational Psychology Review*, 34(1), 451-472. <https://doi.org/10.1007/s10648-021-09636-3>
- Rahayu, W. I., Leksono, S. M., & Nulhakim, L. (2024). Mobile Learning Based Learning Using Etno Edu Games to Improve Students' Critical Thinking and Cognitive Abilities on IPAS Subjects in Grade IV Elementary School. *Jurnal Penelitian Pendidikan IPA*, 10(9), 6504-6515.
<https://doi.org/10.29303/jppipa.v10i9.8339>
- Ramansyah, W. (2015). Pengembangan Education Game (Edugame) Berbasis Android pada Mata Pelajaran Bahasa Inggris untuk Peserta Didik Sekolah Dasar. *DUTIC: Jurnal Ilmiah Pendidikan dan Informatika*, 2(1), 1-9.
<https://doi.org/10.21107/edutic.v2i1.1560>
- Rizki, I. A., Suprpto, N., & Admoko, S. (2022). Exploration of Physics Concepts with Traditional Engklek (Hopscotch) Game: Is It Potential in Physics Ethno-STEM Learning? *Jurnal ilmiah pendidikan fisika Al-Biruni*, 11(1), 19-33. Retrieved from
<https://ejournal.radenintan.ac.id/index.php/al-biruni/index>
- Rokhim, D. A., Nora, Sari, A. P., & Rokayah, D. Y. (2022). Implementation of Hy-Bon Edugame Based on Gender of Students' Learning Interest in Hydrocarbon. *J-PEK: Jurnal Pembelajaran Kimia*, 7(2), 73-79.
<https://doi.org/10.17977/um026v7i22022p073>
- Suarmawan, K. A., Meitriana, M. A., & Haris, I. A. (2019). Faktor-Faktor Eksternal yang Mempengaruhi Hasil Belajar Ilmu Pengetahuan Sosial Siswa Kelas VIII di SMP Negeri 3 Singaraja Tahun Ajaran 2018/2019. *Jurnal Pendidikan Ekonomi UNDIKSHA*, 11(2), 528-539.
<https://doi.org/10.23887/jjpe.v11i2.21558>
- Suriyana, S., & Nizarrahmadi, N. (2022). Game Edukasi Digital Ular Tangga Bermuatan Etnomatematika di Sekolah Dasar. *Jurnal Pendidikan Dasar*, 10(2), 266-272. Retrieved from
<https://scholar.archive.org/work/kgnbmbsuivfttouzcgjvzbrpva/access/wayback/https://jurnalstkipmelawi.ac.id/index.php/JPD/article/download/908/pdf>
- Thahir, R. (2021). Pengaruh Pembelajaran Daring Berbasis Google Classroom Terhadap Hasil Belajar Mahasiswa Pendidikan Biologi. *EDUKATIF: Jurnal Ilmu Pendidikan*, 3(4), 1936-1944.
<https://doi.org/10.31004/edukatif.v3i4.1123>
- Toharudin, U., Kurniawan, I. S., & Fisher, D. (2021). Sundanese Traditional Game 'Bebentengan' (Castle): Development of Learning Method Based on Sundanese Local Wisdom. *European Journal of Educational Research*, 10(1), 199-209.
<https://doi.org/10.12973/eu-jer.10.1.199>
- Zain, S. (2021). Digital transformation trends in education. In *Future directions in digital information*. Chandos Publishing.
<https://doi.org/10.1016/B978-0-12-822144-0.00036-7>
- Zidny, R., Sjöström, J., & Eilks, I. (2020). A multi-perspective reflection on how indigenous knowledge and related ideas can improve science education for sustainability. *Science & Education*, 29(1), 145-185.
<https://doi.org/10.1007/s11191-019-00100-x>